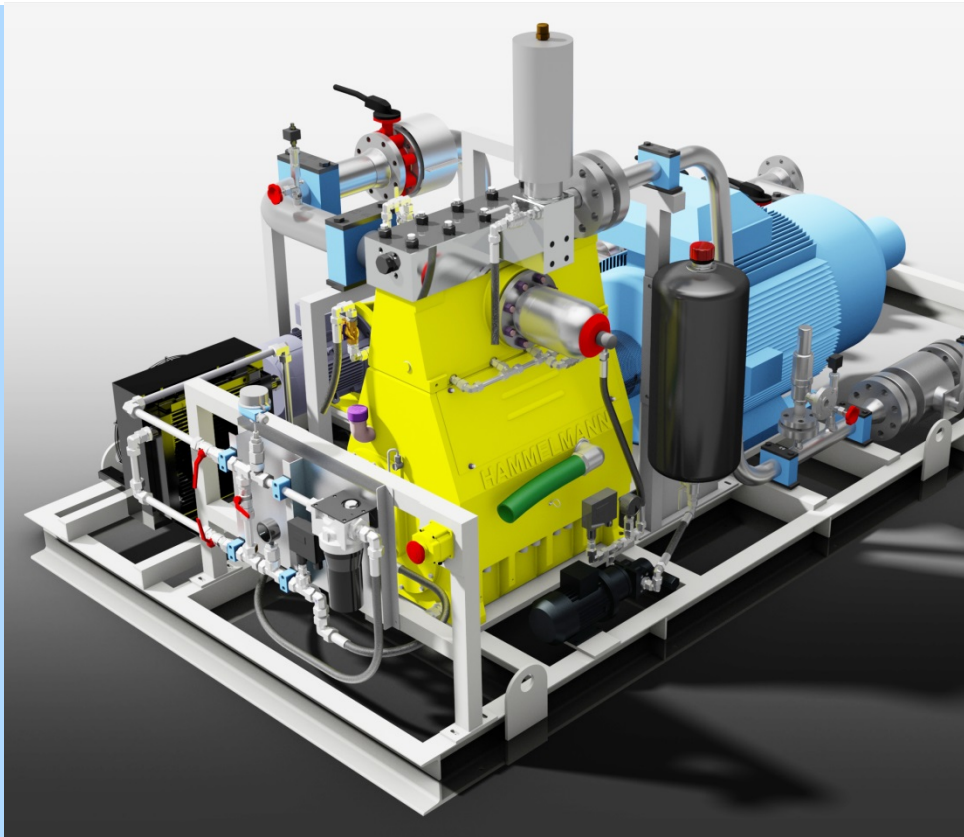
Pumps and Turnkey Solutions
Made by SONNEK in Austria



Contact:
SONNEK Engineering GmbH
Gassergasse 34
A-1050 Vienna
Austria

info@sonnek.com
+43 1 5452292

SONNEK – about us

SONNEK is a family owned group with 4 sites in Austria, Romania and Czech Republic originally founded in the year 1930 in Vienna, Austria.

The SONNEK business in all countries is mainly focused on:

- Engineering and supplying pumps, filters and related equipment
- Engineering, designing and manufacturing turnkey solutions in skid or containerized construction for remote locations like oil- and gas fields, civil and underground engineering or chemical applications
- Installation, service, maintenance of industrial equipment for liquid applications

Over the years SONNEK group very successfully developed its international business and today employs around 60 well trained specialists dedicated to the SONNEK activities.

In 2014 SONNEK decided to close a contract with the international investor STERLING GRACE based in Montreux / Switzerland for even greater developments and faster international expansion in new challenging markets.

Over 50 years of experience in the field of liquid technology

Praha

Vienna-
headquarter

Ternitz

Sibiu

A team of engineers and technicians for:

- Technical advice for pumps and liquid technology
- Pump selection
- Pumping units
- System integration
- Commissioning
- Service & maintenance

..... extensive experience for various pumping systems

EN ISO 9001
ZNr. 20 100 102005717
TÜV AUSTRIA
MANAGEMENTSYSTEM ZERTIFIZIERT
TÜV AUSTRIA CERT GMBH
OHSAS 18001
ZNr. 20 116 102005718

SONNEK production sites

SONNEK Austria:

- Completion of Ternitz site in 2015 – 2000m² covered production area

SONNEK Romania:

- 1000m² covered production area for the Romanian market

Manufacturing of pump skids and turnkey systems
Pump service
Pump test stand

SONNEK Sale- Servicepartner in IRAN

Pars Marine Industry Co.
EPC Contractor & Equipment Supplier
+98 21 880 420 14
sales@parsmarineco.com
www.parsmarineco.com
Apt2, No.8, North Ararat St, Kordestan Expy, Niayesh

Ternitz production site

SONNEK production site in Ternitz - Austria

Certification:

- ISO 9001(TÜV Austria CERT)
- OHSAS 18001(TÜV Austria CERT)
- ISO 3834-3 Quality of welding technology
- EN 1090-1 Manufacturer certification for steel constructions

Scope of work

- CAD Design
- Steel construction
- Construction of pump stations
- Pipeline construction
- Plant construction
- Ventilation systems
- Pump repair and pump optimisation
- Service and commissioning

Ternitz production site

Zertifikat der Konformität

der

werkseigenen Produktionskontrolle (WPK)
0531 – CPR – 1090 – 0898

Gemäß der Verordnung (EU) Nr. 305/2011 des Europäischen Parlaments und des Rates vom 9. März 2011 (Bauproduktenverordnung - CPR) gilt dieses Zertifikat für das Bauprodukt

Tragende Stahlbauteile

Harmonisierte Norm	Art / Ausführungsklasse des Bauproduktes	Deklarationsmethode
EN 1090-1:2012	Tragwerke und Bauteile aus Stahl bis EXC2 nach EN 1090-2	1, 2, 3a und 3b nach Tabelle A.1 der EN 1090-1

hergestellt durch:

Sonnek Metall- und Anlagenbau GmbH
Schoellergasse 7
2630 Ternitz, Österreich

Die Notifizierte Stelle, Kennnummer 0531, hat die laufende Überwachung des Werkes und der werkseigenen Produktionskontrolle, sowie die Beurteilung und Zertifizierung der werkseigenen Produktionskontrolle durchgeführt.

TÜV SÜD Landesgesellschaft Österreich GmbH,

Bestätigung: Dieses Zertifikat bescheinigt, dass alle Vorschriften über die Bewertung und Überprüfung der Leistungsbeständigkeit beschrieben im Anhang ZA der harmonisierten Norm

EN 1090-1:2012

entsprechend System 2+ angewendet werden und dass die werkseigene Produktionskontrolle alle darin vorgeschriebenen Anforderungen erfüllt.

Gültigkeitsbeginn (Tag der Erstausstellung): 18.04.2013

Zertifikatsgültigkeit bis: 18.04.2019

Bemerkungen: Mit geltendes Dokument ist der Auditbericht: Nr.: 725040164-MWa

Ausstellungsort/-datum: Linz, 26.04.2016

Dipl.-Ing. G. Bachler
Zertifizierstelle für Produkte

Tel.: +43 (0)1 798 26 26-0
Fax: +43 (0)1 798 26 26-77

55-044 - Zertifikat der Konformität der WPK EN 1090-1_16.05.2013

ZERTIFIKAT ◆ CERTIFICATE ◆ 認証書 ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

ZERTIFIKAT

CERTIFICATE

0531 – ST – 3834 – 0899

Die Firma/ *the company*

Sonnek Metall- und Anlagenbau GmbH
Schoellergasse 7
2630 Ternitz

erfüllt die schweißtechnischen **Standard Qualitätsanforderungen** nach *fulfills the* **standard quality requirement** *according to*

EN ISO 3834-3

Der Umfang des Nachweises ist in der Anlage aufgeführt.
For the Range mentioned in the enclosure to this certificate

Das Zertifikat gilt bis zum April 2019
The certificate expires in April 2019

Auftrag/Bericht ; *order/report No:* 725040164 - MWa

Wien/vienna, 26.04.2016

TÜV SÜD Landesgesellschaft Österreich GmbH
Certification body

Dipl.-Ing. G. Bachler
Zertifizierstelle für Produkte
Certification Body

12 SÜD 035 Zertifikat EN 3834 06.05.2012

ZERTIFIKAT ◆ CERTIFICATE ◆ 認証書 ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

CERTIFICATE

TÜV AUSTRIA

Management system as per
EN ISO 9001:2008 and OHSAS 18001:2007

In accordance with TÜV AUSTRIA CERT procedures, it is hereby certified that

SONNEK ENGINEERING

Sonnek Engineering GmbH
Gassergasse 34
A-1050 Wien
Inklusive Fertigungsstandort Ternitz

applies a management system in line with the above standard for the following scope

Design, engineering, production and service of pumping systems, plant construction in general and turnkey solutions for produced water injection, water boosting, chemical and polymer dosing, loading and de-loading of liquids, water treatment in particular

Certificate Registration No. 20 100 102005717 / 00
20 116 102005718 / 00

Valid until 2017-06-05

Certification Body
at TÜV AUSTRIA CERT GMBH

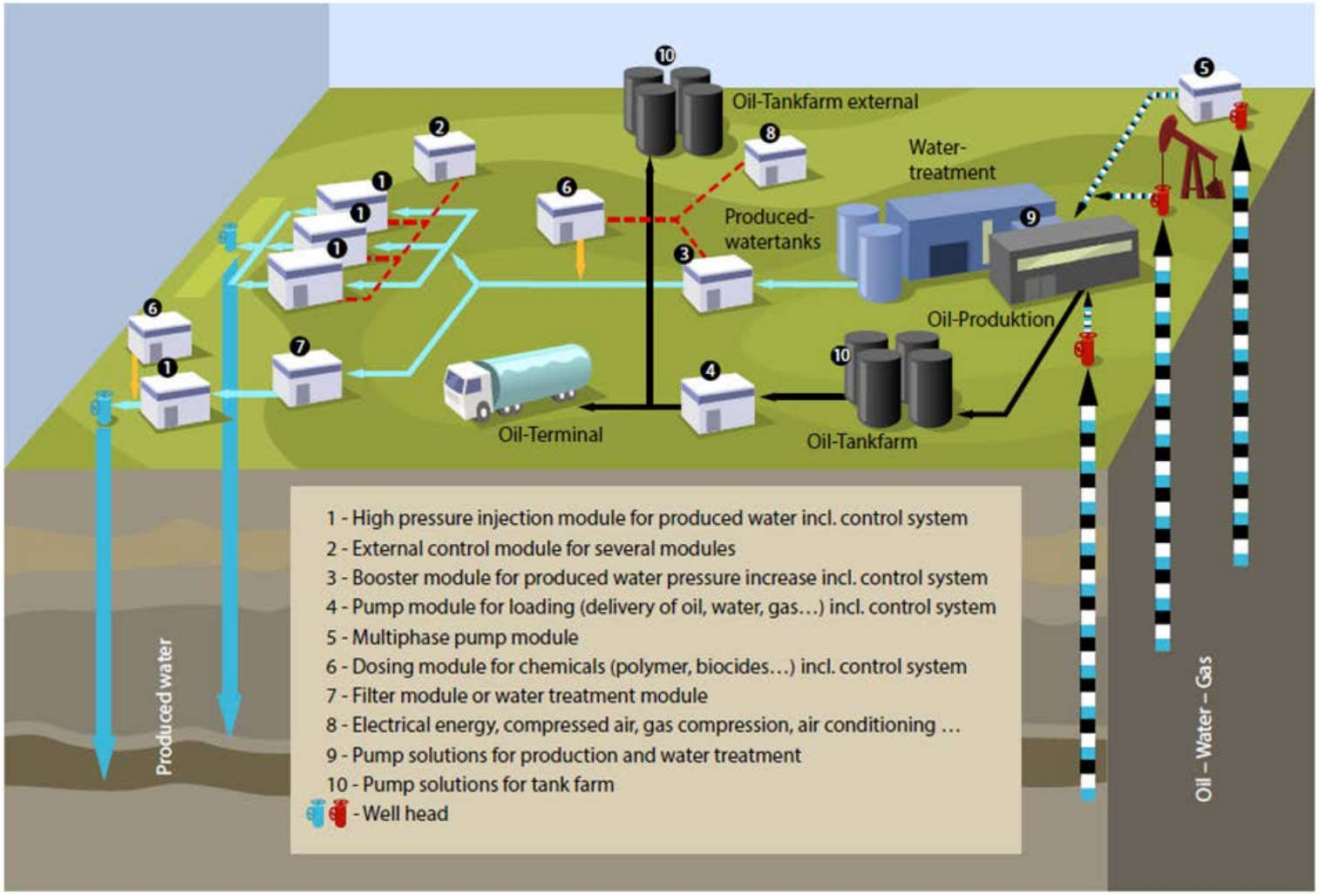
Vienna, 2016-05-25

This certification was conducted in accordance with TÜV AUSTRIA CERT auditing and certification procedures and is subject to regular surveillance audits.
TÜV AUSTRIA CERT GMBH Krugerstraße 16 A-1015 Wien www.tuv.at

ZERTIFIKAT | CERTIFICATE | CERTIFICAT | CERTIFICADO | СЕРТИФИКАТ | 認証書 | 인증서

Plug & Pump Turn Key Modules

for up- and midstream applications



Turn Key Modules

SONNEK philosophy of modular construction systems

Main advantages of a „LEGO“ system for oil fields:

- SONNEK supplies a ready to go container or skid based solution for each single task
- Plugged together it represents a complete produced water solution
- Perfect for the cost-effective redesign of existing fields and EOR - enhanced oil recovery
- Delivery of pretested turnkey solutions with no or minimum work on site
- Single source supply
- Flexible systems that can easily be adapted to the changing requirements on the fields
- Long life time and state of the art technology following international oil standards

References

Extract of references: Sonnek Engineering & Hammelmann:

HAMMELMANN

Plug & Pump

OMV

PETROM

bhpbilliton

RAG.AUSTRIA.ENERGIE

bp

Agip

Schlumberger

Shell

Chevron

Statoil

RWE Dea

TEXACO

800 × 800 - logoprofi.com

MOL

WABAG

Turn Key Modules

High pressure water injection on oil fields

Sonnek „Plug&Pump modules“ for produced water injection on mature oil fields:

- **2a injection pump modules**
- **2b booster pump modules**
- **3 chemical dosing modules**

The water cut increases constantly on mature oil fields. Some oil fields produce oil profitably even at a water content of up to 95% others close their oil wells at a water content of 30%.

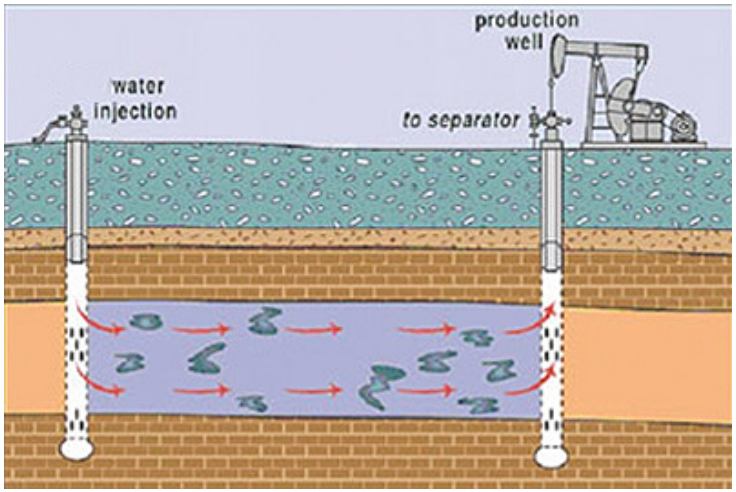
A major key of success to operate a mature oil field is the optimal handling of produced water. After separating the saltwater from the produced oil it will typically be reinjected in flood wells for disposal and / or to maintain or increase the reservoir pressure.

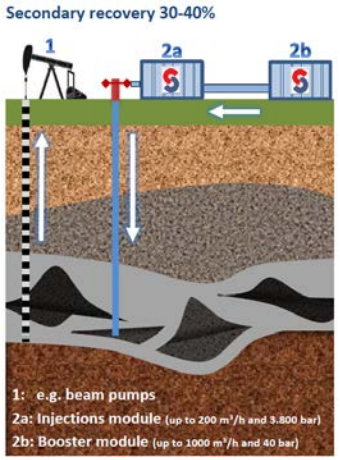
The reinjection of produced water is part of the secondary enhanced oil recovery. Statistically speaking the total oil production of an existing oil field can doubled over its complete life time.

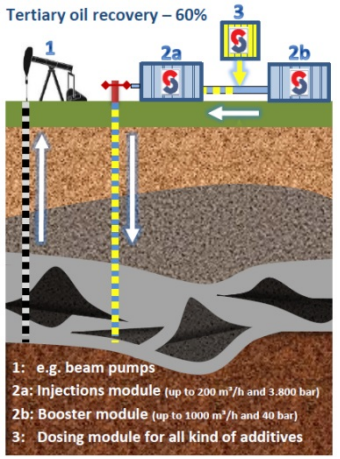
The produced water then goes in an endless circle between oil well, oil separation, water treatment and high pressure reinjection in flood wells.

Worldwide experienced oilfield engineers agree in the following saying:

„The key for cheap oil production on mature oil fields is the optimization of the produced water cycle“







Turn key systems

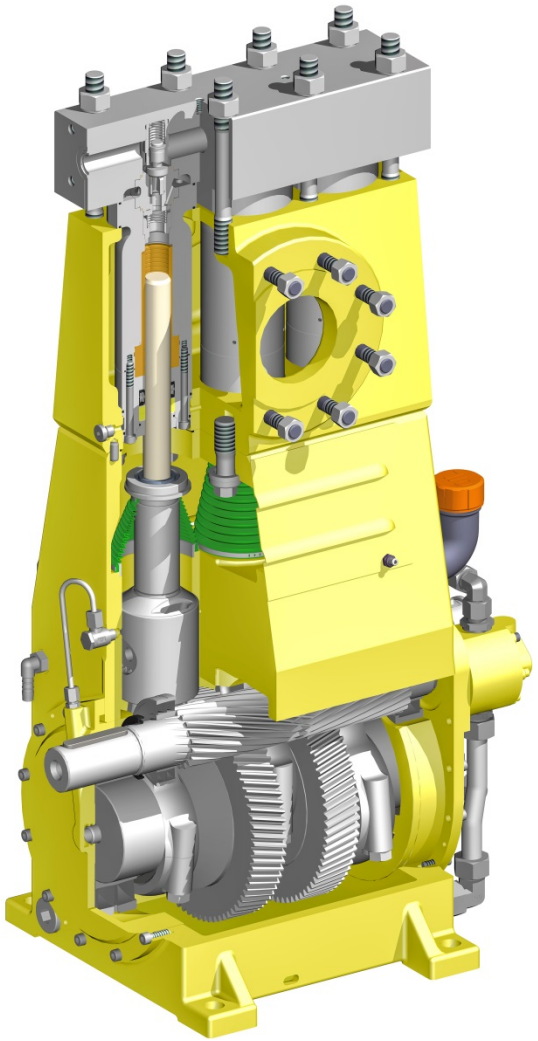
High pressure water injection for oil wells

Key challenges for water injection systems:

- Continuous operation –
  24 hours per day / 8760 hours per year
- Mobile units for easy transfer to other locations
- Handling corrosive salt water with some impurities of sand, oil, gas and slurry
- Water temperatures up to 80°C
- Low-maintenance operation in remote locations
- High energy efficiency for lowest possible energy costs
- Zero emission of produced water into the environment
- Low noise level for operation near settlement areas
- Automatic operation even under widely changing conditions
- Meeting all local health and safety requirements
- Fulfilling all engineering requirements of the operating oil- and gas company

Turn Key Modules

High pressure water injection on oil fields



HAMMELMANN plunger pump inside

Important features:

- Solid ceramic plungers – high corrosion and abrasion resistance
- Outstanding efficiency degree for all duty points
- Small footprint – ideal for modular solutions
- Bellow sealings for fluids with high salt content – excellent protection of the drive end
- Integrated speed reducer with twin helical gears
- API 674 design

Options:

- Zero emission system for hazardous ingredients like H_2S
- ATEX design for explosive atmosphere

Limits:

- Flow rate: up to 175m³/h
- Pressure: up to 3500 bar
- Drive power: up to 1000kW

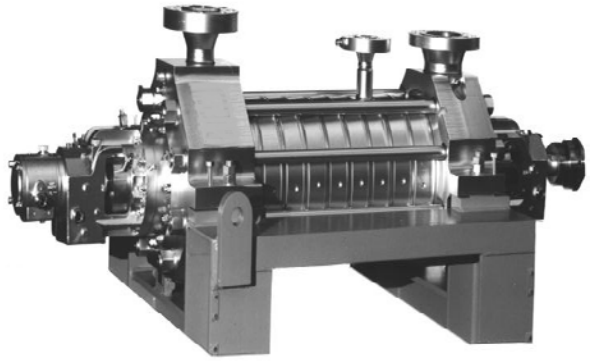
Turn Key Modules

High pressure water injection on oil fields

HAMMELMANN plunger pumps versus centrifugal pumps

Efficiency at full output: 93%
Efficiency at half output: 93%
Flow range: typically 1:10
Motor for 42m³/h (1000m³/d) at 160 bar: 200kW
Reliable system and simple maintenance
Easy to handle HAMMELMANN seal packs

Perfect solution for low to medium flow (up to 100m³/h per system) and high pressure



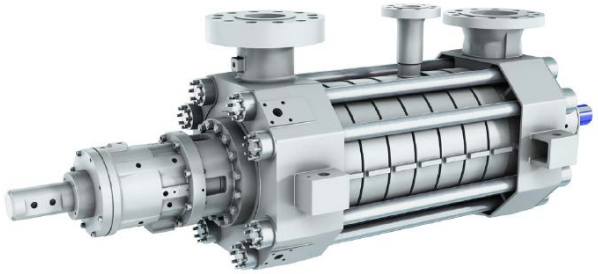
Efficiency at full output: 78%
Efficiency at half output: 60%
Flow range: low
Motor for 42m³/h (1000m³/d) at 160 bar: 315kW
Reliable system and low maintenance downstream of high quality water treatment process
High grade mechanical seal design required

Perfect solution for high flow and low to medium pressure

Turn Key WI System for MAERSK Dunga field

SULZER

MD High Pressure Stage Casing Pump



Bruchsal and Lohmar, Germany

At both German production facilities in Bruchsal and Lohmar, there are full manufacturing capabilities such as machining, tool room, motor production, assembly, control panel assembly, painting and testing up to 10,000 l/s – 1,000 kW 50/60 Hz. Besides, Lohmar is equipped with a mixer test-rig for thrust measurements, aerator tests and an extensive test set-up for rag handling and non-clogging observations. Bruchsal benefits from a state-of-the-art packaging bay handling large aggregates up to 32 tons; it is also equipped with a testing facility for pumps up to 4 MW.

Turn Key WI System for MAERSK Dunga field

P.M.C.

SONNEK ENGINEERING

Plug & Pump

MD HIGH PRESSURE STAGE CASING PUMP

FEATURES AND BENEFITS

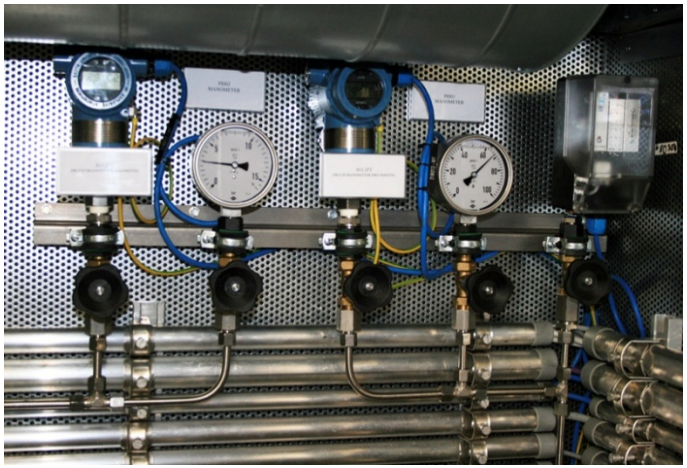
- Modular hydraulics for high efficiency in a wide range of operating conditions
- Centerline mounted with large branch sizes for optimized inlet flow, low noise level and higher allowable forces and moments
- Unaffected by rapid temperature variations
- Stiff shaft design for critical speeds above the maximum operating speed
- Multiple screws mechanical tensioners are used on large sizes to allow simpler tightening and loosening

KEY CHARACTERISTICS

Capacities	up to 1,000 m^3/h / 5,000 USgpm
Heads	up to 2,400 m / 8,200 ft
Pressures	up to 350 bar / 5,080 psi
Temperatures	up to 210°C / 410°F

Turn Key Systems

High pressure WI instrumentation



Instrumentation:

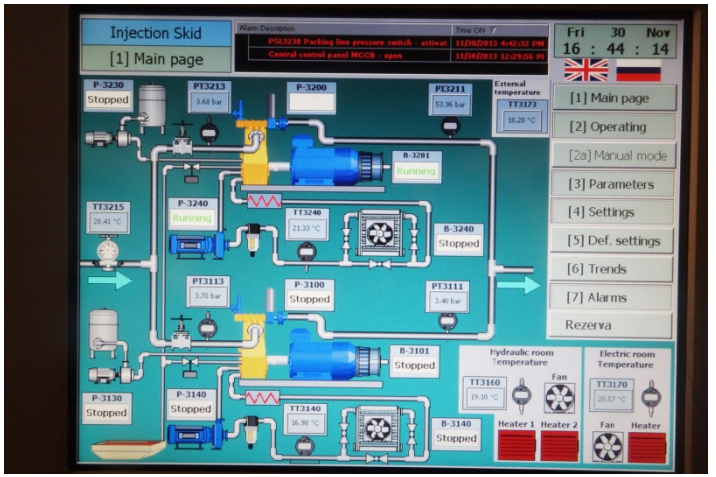
- Pressure sensors on low and high pressure side
- Safety pressure switches
- Temperature sensors
- Flowmetering (Inductive Flowmeter or Coriolis)
- Level probes
- Additional sensors for system monitoring
- Sensors from E+H, EMERSON, WIKA or acc. customer specification

Explosion protection according local requirements:

- No explosion protection or
- Explosion protection concept with gas detection system or
- Complete design acc. ATEX category 2 or 3 (zone 1 or 2)

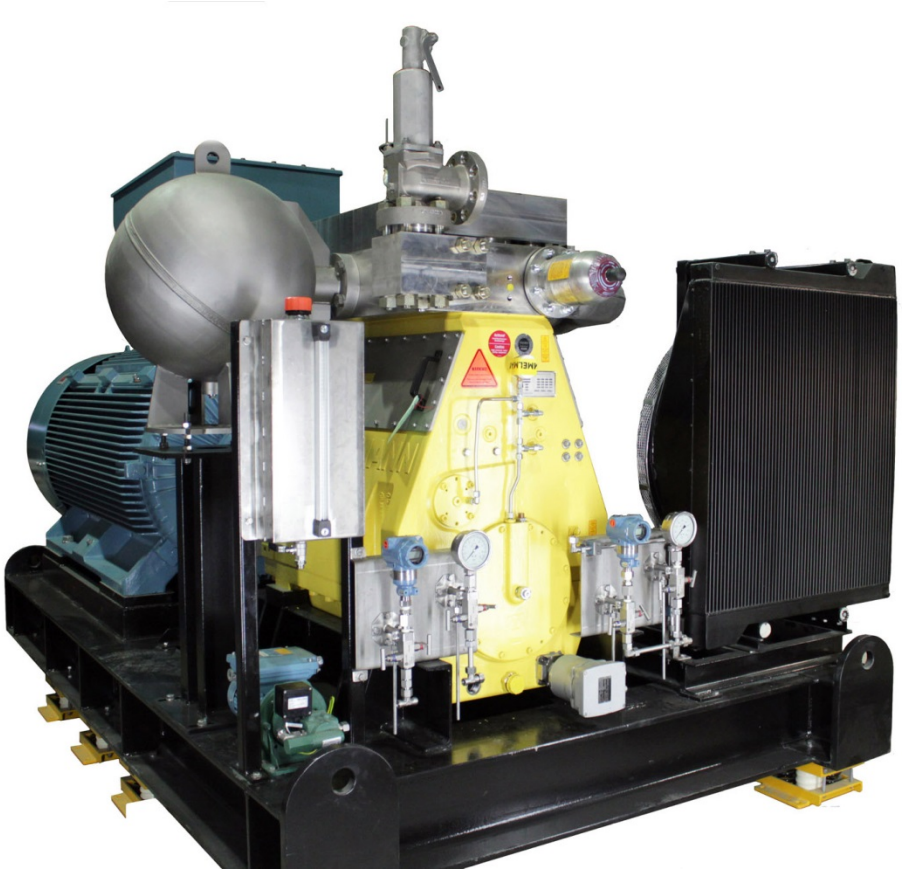
Turn Key Systems

Electric control system



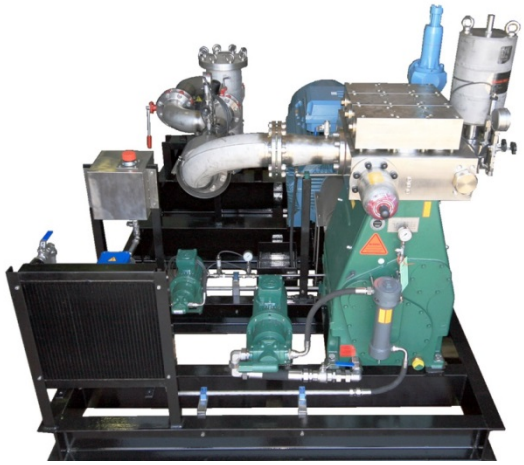
Turn Key Systems

High pressure water injection for oil wells



Main platform

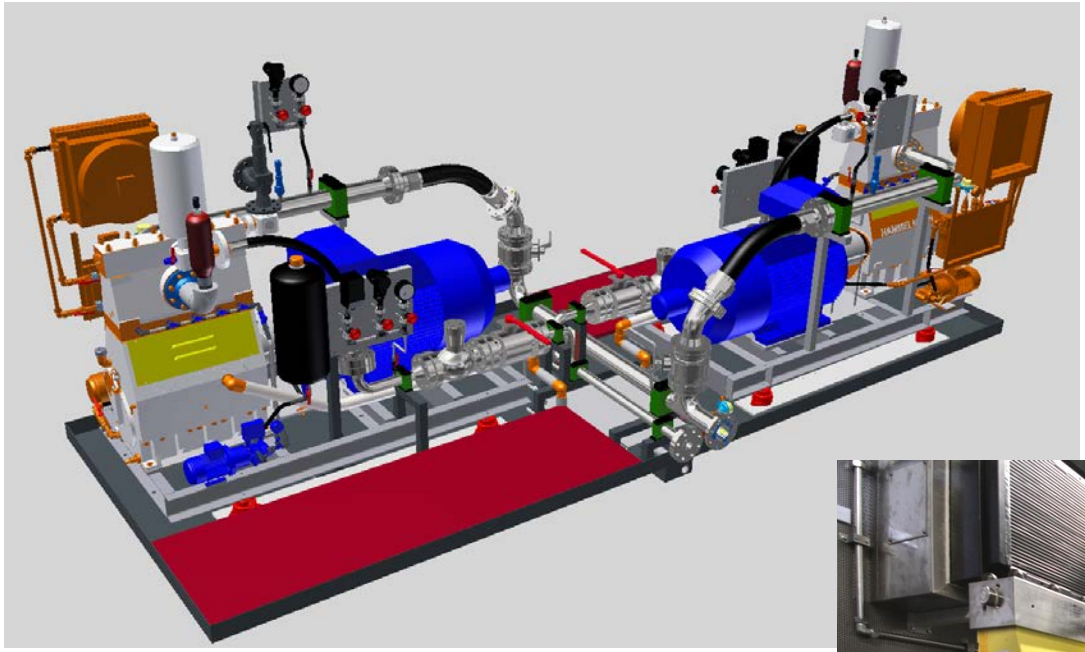
Gloria platform – black sea



HDP487 offshore skid 1200m³/d – 250bar

Turn Key Modules

High pressure water injection on oil fields

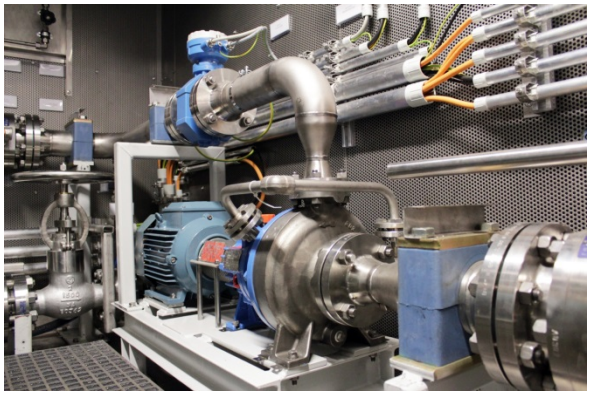


SONNEK dual pump solution

Kazakhstan – caspian sea region

Turn Key Modules

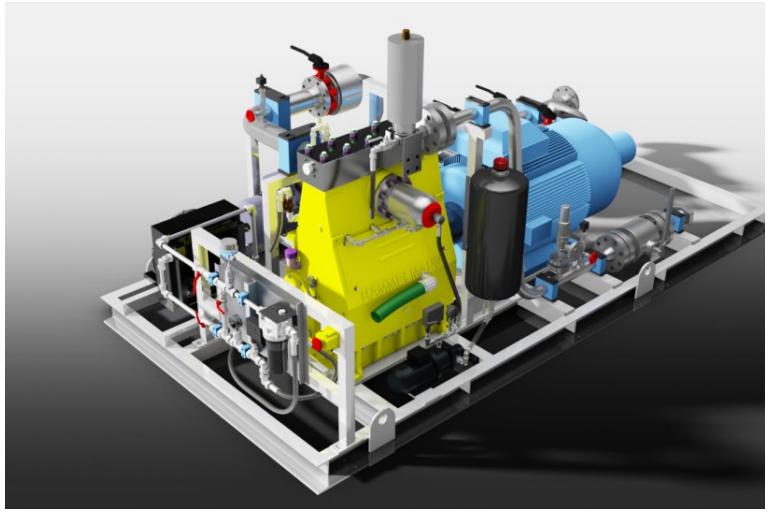
High pressure water injection

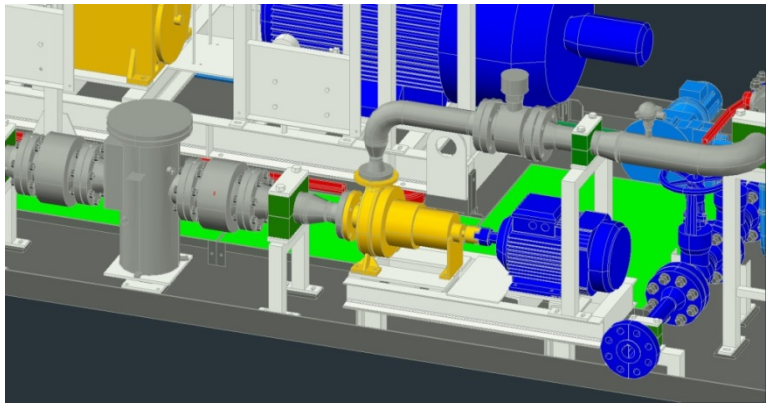


SONNEK oil field solution – produced water injection in Kazakhstan

Turn Key Systems

High pressure water injection for oil wells





SONNEK 3D CAD construction

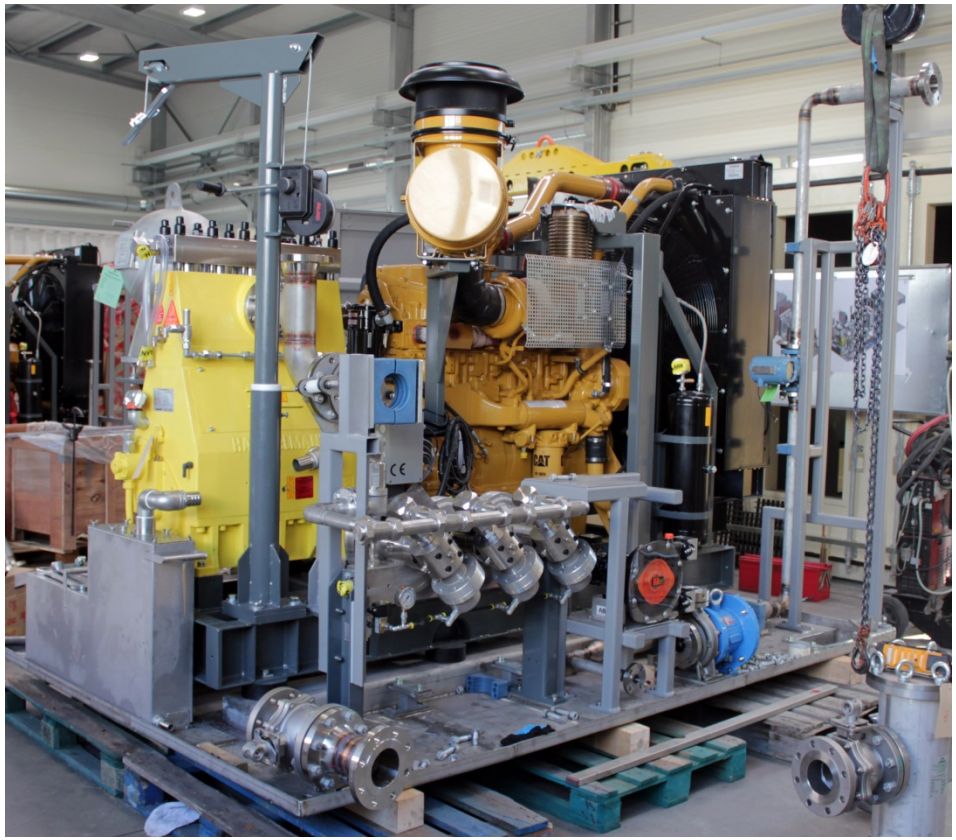
Skid solution

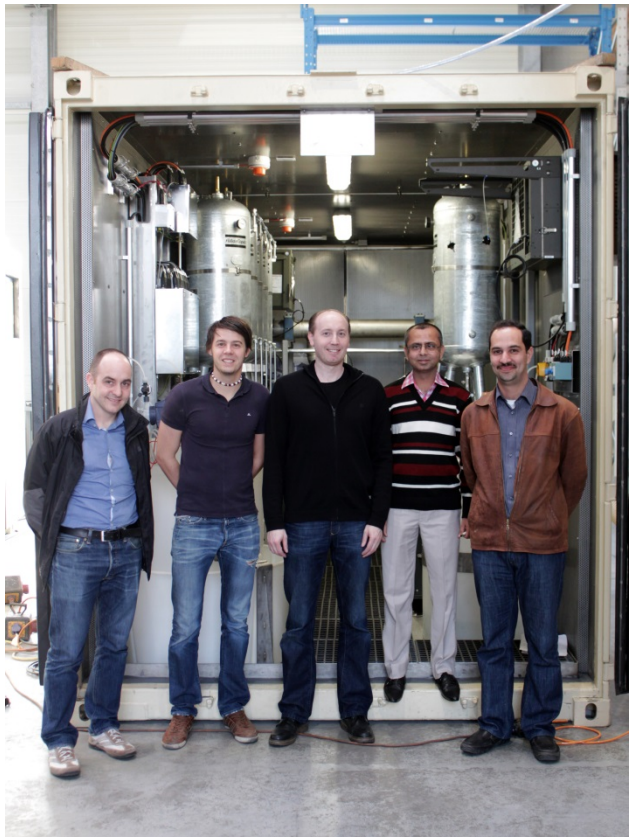
Standard single pump solution with booster pump and electric control room

Realized solution in the Gabon rain forest

Turn Key Modules

High pressure water injection

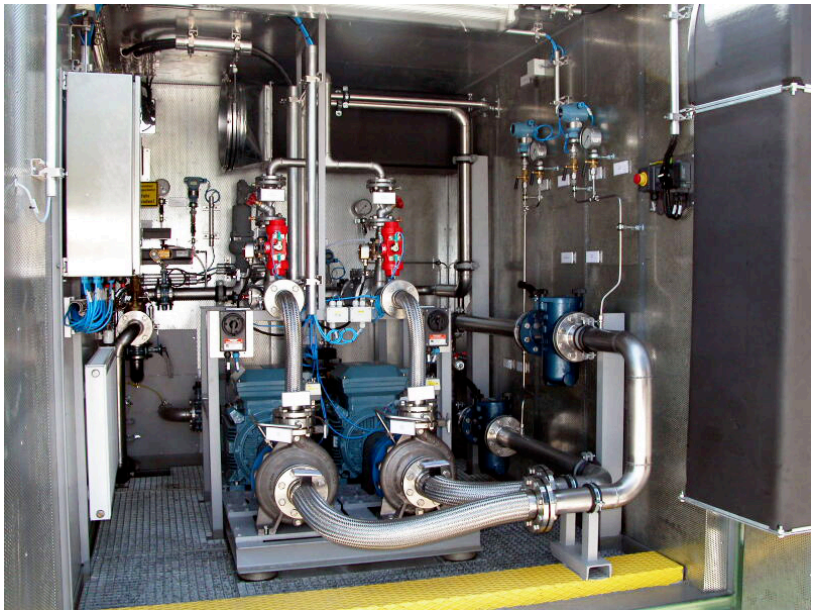


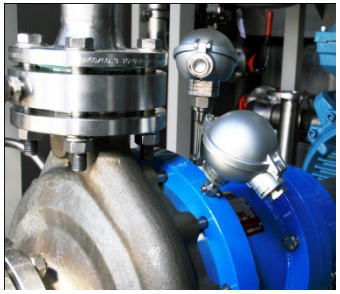


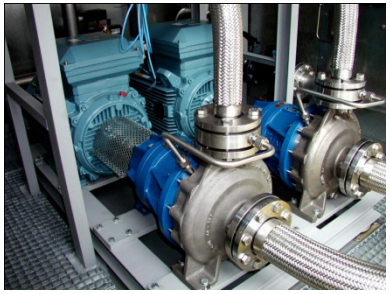
SONNEK FAT for MOL Pakistan 9.3.16 in Ternitz

Turn Key Systems

Booster systems for salt water







Mobile booster systems for salt water:

Special container in heavy duty construction

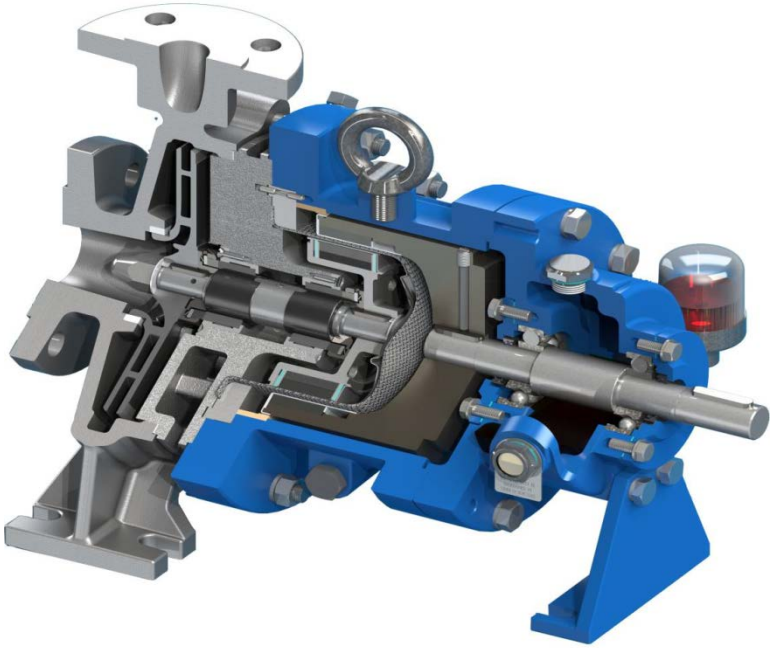
- internal stainless steel design resistant against salt water and salt spray.
- heating and cooling system to prevent freezing in winter and overheating in summer
- sound proof design
- leak-proof stainless steel collecting tray to prevent penetration of production water in the surrounding soil in case of system failure.

Pump System:

- magnetic driven leackfree centrifugal pumps or mutistage pumps with double mechanical seal and pressurized thermosyphon system
- adjustable flow rate or constant outlet pressure through frequency converter
- pressure and temperature sensors
- flowmeter
- additional sensors for system monitoring
- explosion proofed design acc. ATEX category 2 or 3 for zone 1 or 2

Turn Key Modules

Magnet driven sealless pumps for produced water



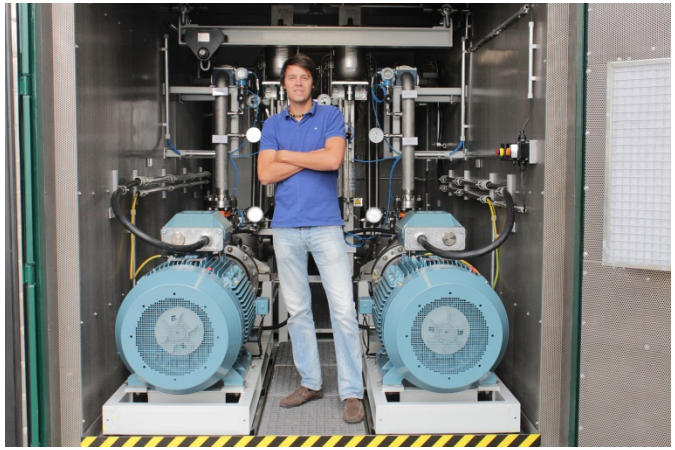
- Mag-drive sealless pump design to avoid crystallization in the mechanical seal due to high chlorid content
- Oversized silicon carbid internal bearings for long life time with abrasiv sand particles in the produced water
- Pump design according ISO, ANSI or API
- Construction material AISI 316, Duplex or Hastelloy

- Hybrid shroud system
- Inner shell: corrosion resistent seamless metal shroud
- Outer shell: reinforced carbon fiber for mechanical strength
- Benefit: extrem low shroud losses and highest efficiency

- Hybrid shroud with temperature control for pump protection

Turn Key Systems

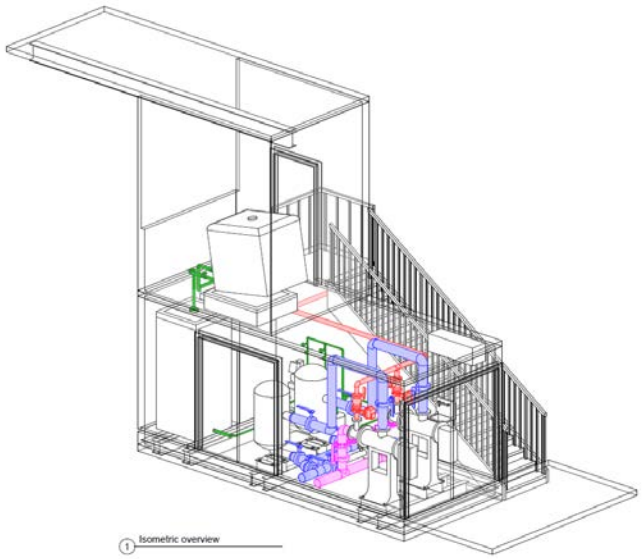
Booster systems for salt water



Booster Module with API610 pumps and pressurized buffer system for double mechanical sealing

Turn Key Modules

EOR solution for polymer flooding



Complete system for dosing dissolved polymer solution into the high pressure produced water line:

Medium:	Polymer-solution
Concentration:	10:000ppm
Flow rate:	5m³/h

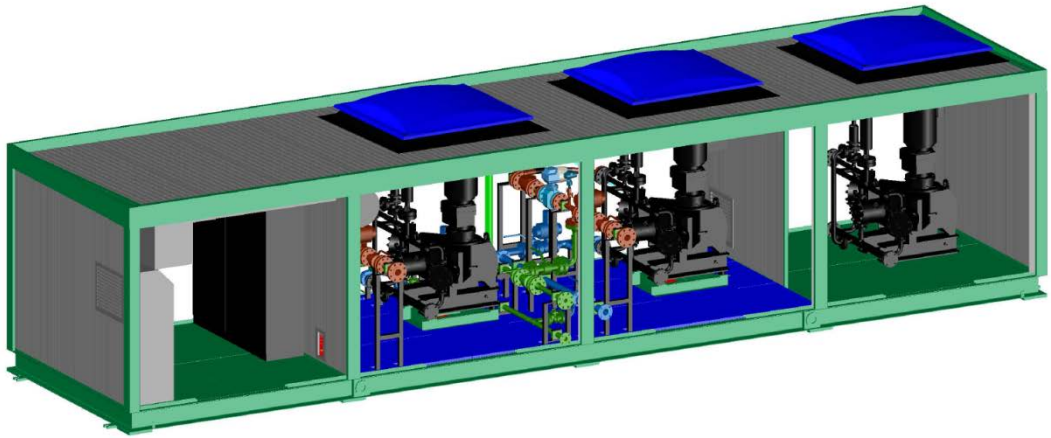
12m x 3m container module including:

- 3 pcs BRAN & LÜBBE 120 bar dosing pumps
- Sophisticated pulsation dampening system
- Leak-proof stainless steel trays covering the entire wet room with integrated pump sump
- Heating, venting and light system
- Electric control room with Siemens S7 SPS and HVAC system

Prefiltration system:

Medium:	Produced water for Polymer solution
Filter system:	LENZING Optifil 10µm

2 Biozide dosing stations



Turn Key Modules

EOR solution for polymer flooding

Turn Key Systems

Testing – FAT and on site

Focus on the best water treatment technology on Oil and Gas fields !

„The key for cheap oil production on mature oil fields is the optimization of the produced water cycle“

SONNEK- strategic philosophy for water treatment

- Handle the raw water as gentle as possible to optimize the treatment process
- Don’t use or minimize process chemicals
- Avoid revolving expandable materials
- Design the system as straightforward and reliable as possible
- Keep the maintenance requirements as low as possible
- Optimize the use of energy

The quality of the treated produced water has a big importance on the economic lifetime of the reservoir and hence on the sustainability of the oilfield

Consequently produced water treatment has to comply with the highest water quality required for long-term reservoir reinjection at lowest impact on oil production price

Focus on the best water treatment technology on Oil and Gas fields !

„The key for cheap oil production on mature oil fields is the optimization of the produced water cycle“

Solutions:

- Mechanical pre filtration
- Oil / Water separation
- Water / solids separation
- Gas / Air Flotation
- Automatic fine filtration
- Polishing filters
- Ultrafiltration systems
- Chemical treatment for EOR

selected SONNEK partners*:

awas water and waste water systems

LiqTech INTERNATIONAL

LENZING TECHNIK

*Integration of other technologies according field requirements

SONNEK water treatment plant

Step 1 – GALAXIE* Tower

Perfect solution for first stage mechanical separation

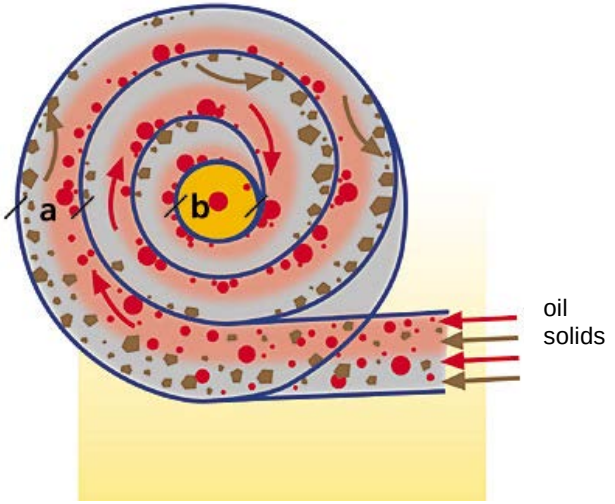
Efficient removal of solids and free oil

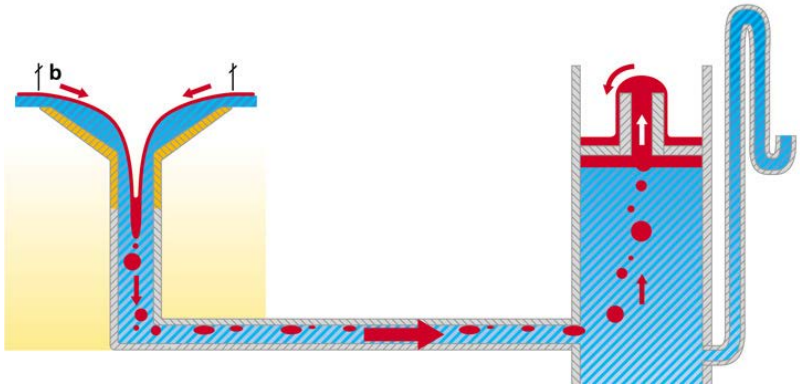
Typically achievable values (TÜV test):

Solid particles > 100µm (sand): 95%**
Free oil: inlet 200ppm – outlet <10ppm**

Benefits:

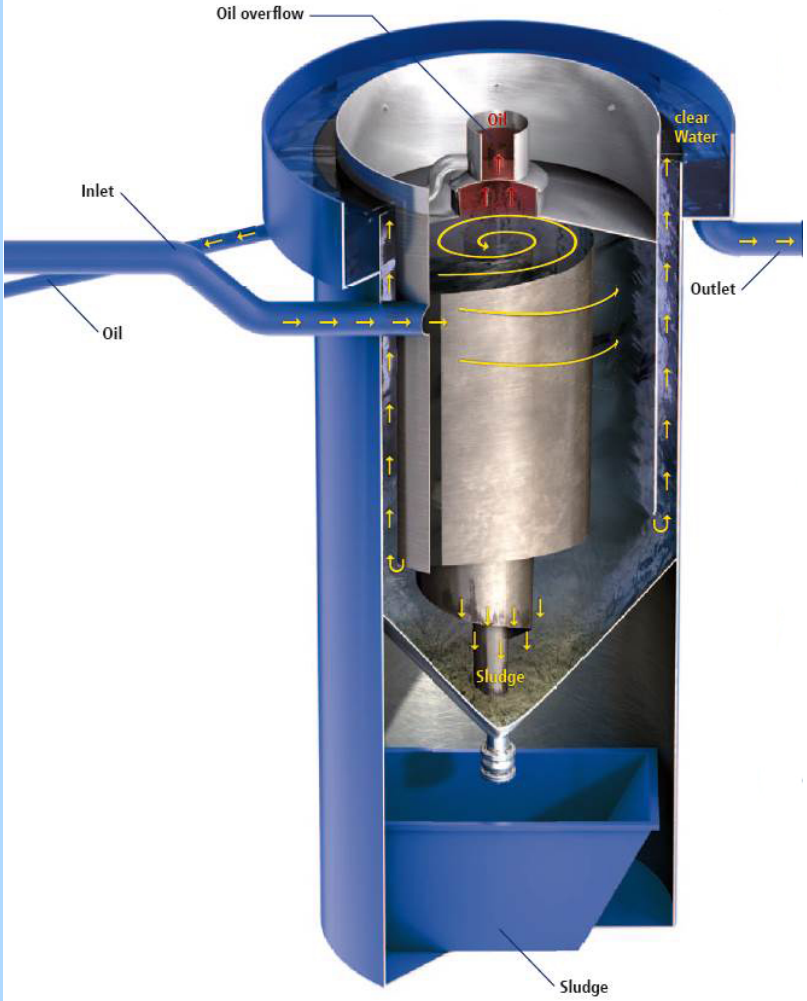
- No clogging due to solids or sticky oil
- No chemicals required
- No mechanical rotating equipment
- No energy consumption
- Separation of highly concentrated oil for reuse
- Almost maintenance free operation
- No spare parts required
- Superiour results at much smaller footprint compared to API separators and parallel plate separators





*GALAXIE is a patended system module of AWAS International in Germany
**Results can vary significantly depending on the properties of the ingredients

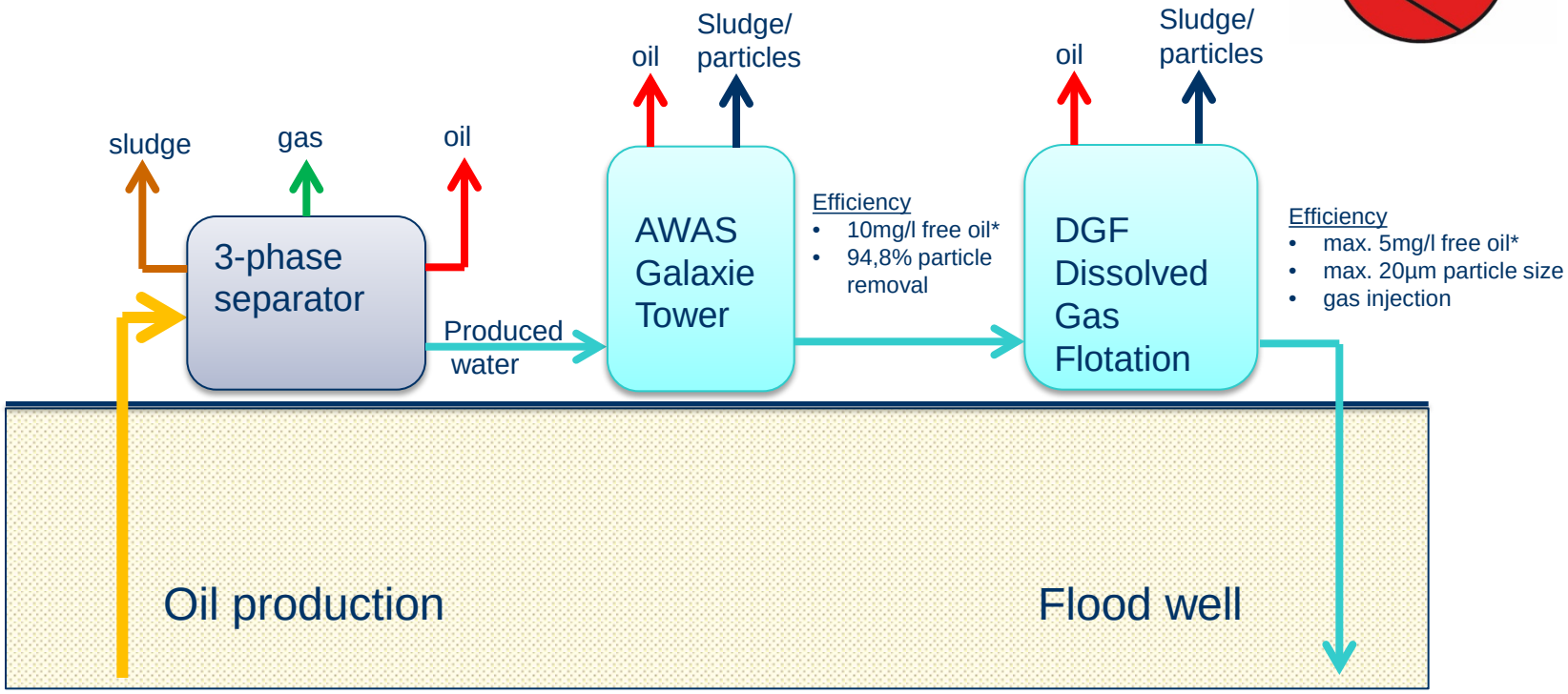
SONNEK water treatment plant



SONNEK & AWAS Galaxie tower

Oman – 5000m³/h – 800.000 bpd

Water treatment - main process



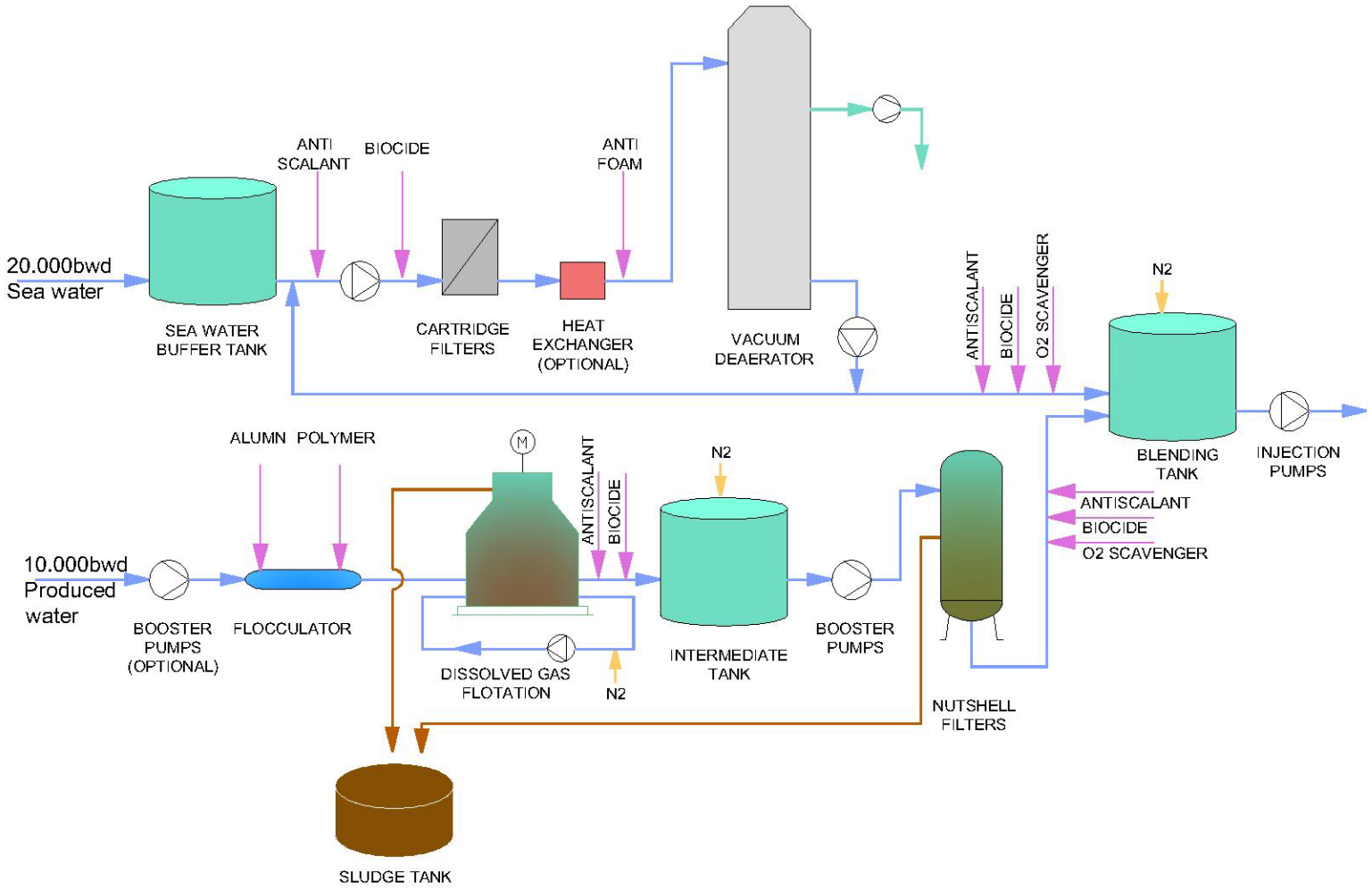
* Only removal of free oil - Emulsified oil content can be higher !

Targeted solution:

- ✓ Nutshell filters only if required for low oil content in outlet (e.g. <= 10ppm)
- ✓ Chemical optimization
- ✓ Small footprint
- ✓ Turnkey container or skid based modular solution

SONNEK WT – case study

BFD– OPTION NUTSHELL FILTERS



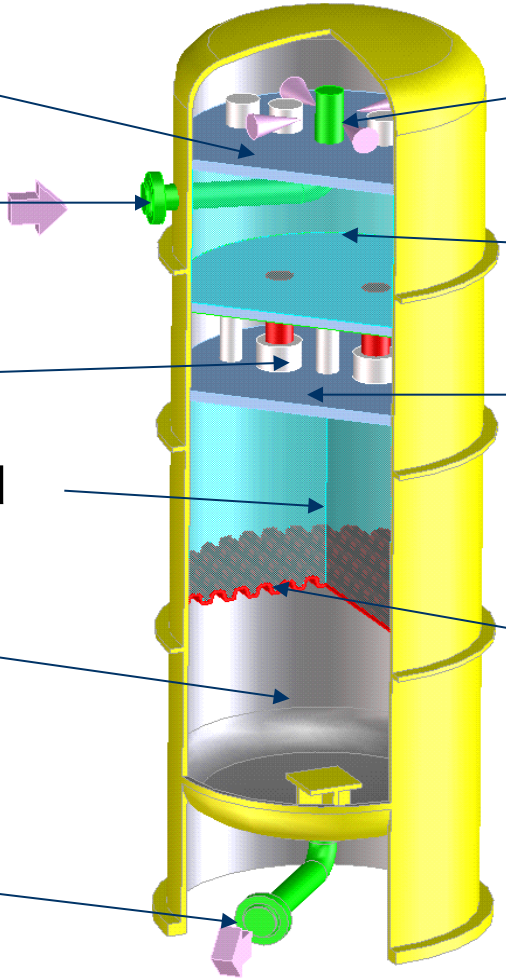
Sea Water treatment Dunga Field

Vacuum Deaerator Package

- Removal of dissolved oxygen from seawater down to 50ppb to minimise downstream corrosion and to prevent aerobic bacteria growth
- Dearation tower with a high contact area
- Two stage dearation process
- Vaccum achieved by liquid ring vacuum pump system
- Dissolved gases are released from the water and removed by the vaccum system
- Anti foam dosing required
- Storage in an accumulation tank beneath the tower
- Sufficent skirt height for acceptble NPSHa of downstream transfer pump
- Low temperature service water for the Liquid ring vacuum pumps preferable (up to the level of feed water temperature)
- Elevated temperature of the produced feed water preferable – nevertheless current design is for water temperature close to 0°C

Sea Water treatment Dunga Field

Vacuum Deaerator Package



Foam retention tray

Water inlet

Interstage seal

Second stage packed bed

Storage section

Water outlet

Spray distributor

First stage packed bed

Redistribution tray

Multibeam support plate

SONNEK produced water treatment

DISSOLVED GAS FLOTATION

High efficient removal of oil and suspended solids

- The heart of the DGF is a vertical range of special "U" shaped elements that allows the use of both co-current and counter-current lamella clarification. The result is a very high hydraulic and solids capacity with excellent clarification efficiency occupying a minimal footprint.

- The DGF is extremely simple from a mechanical point of view - there is one single motor driving the spiral scoop and the carriage. There are no other moving parts.

- DGF units are available in several sizes for flows from 50 to 1250 m3/ hr.

SONNEK produced water treatment

DISSOLVED GAS FLOTATION

Main benefits

- Extremely low footprint versus flow- rate.
- High energy efficiency - very high level of clarification with significantly lower pressurisation rate compared to traditional DAF clarifiers.
- Reduces polymer consumption to the minimum by achieving optimal flocculation with extended mixing time in presence of air bubbles and polymer.

SONNEK water treatment plant

NUTSHELL FILTRATION

Main benefits

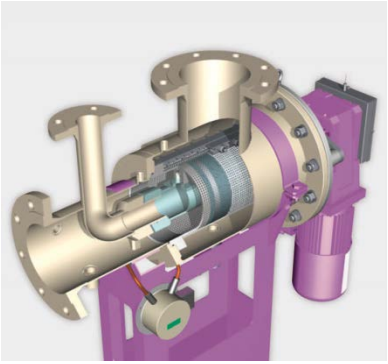
- High flow rates in a compact design which reduces space requirements.
- Deep bed design reduces backwash frequency.
- Elimination of compulsory chemicals for fine removal efficiency or filter cleanup.
- Does not require clean water for filter cleanup.
- Simple automatic design functions.
- Backwash cycle regenerates media without requiring air or gas scouring

Produced water fine filtration
OPTIFIL backwash filter

Automatic selfcleaning filters

Fine filtration down to 3µm

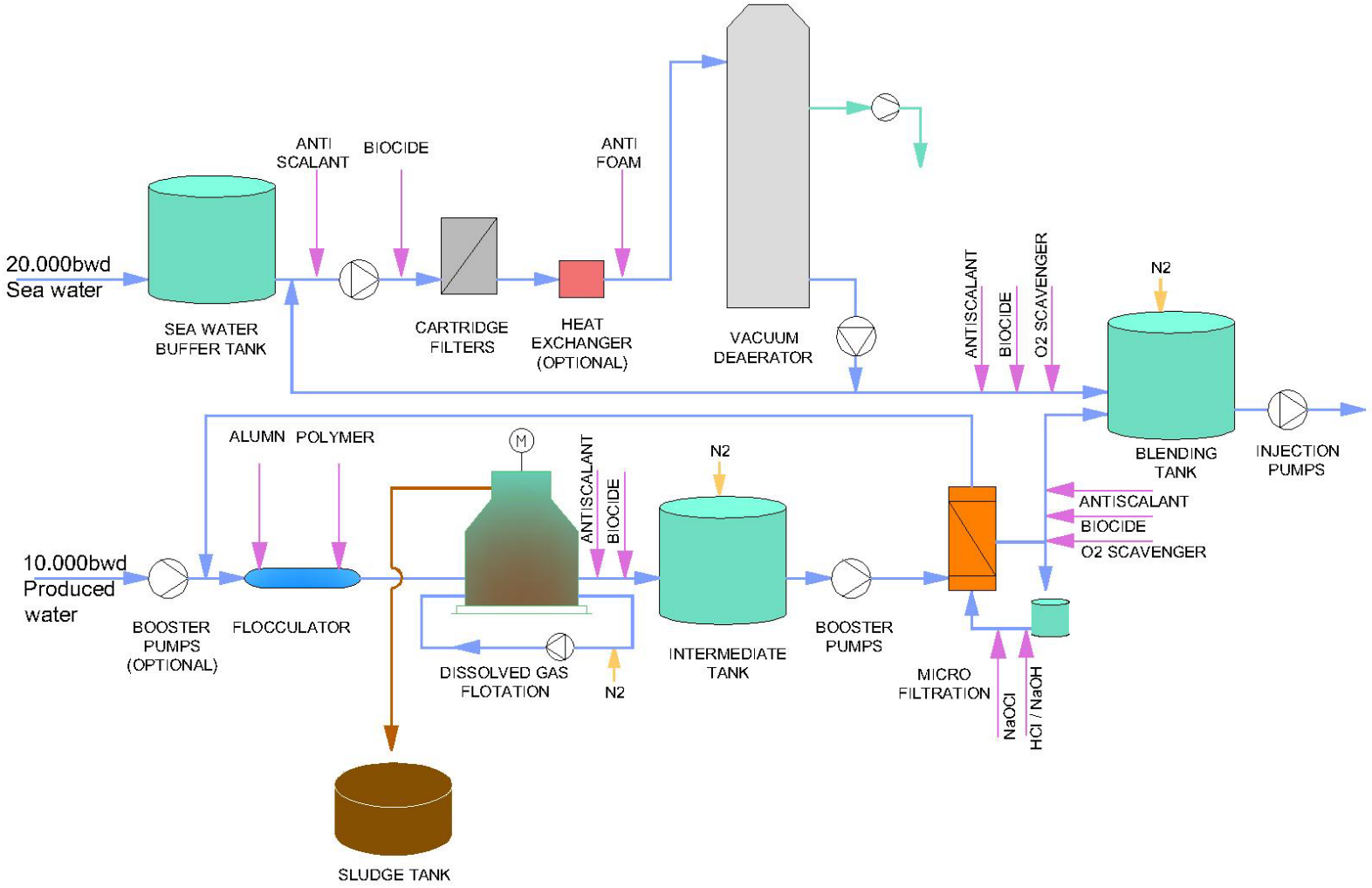
- Fully automatic backwash system
- Minimum losses
- Small footprint
- Simple and easy installation
- Continuous operation during backwash
- Significant lower OPEX – elimination of filter cartridges



flow rate	1 m³/h	1.500 m³/h
fineness of filtration	1 µm	200 µm
flange dimensions	DN 50	DN 350
design pressure	10 bar	16 bar

SONNEK WT case study microfiltration

BFD– OPTION MICRO FILTRATION

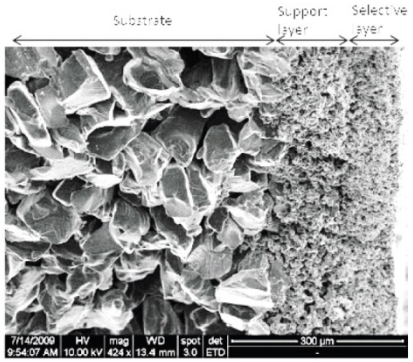


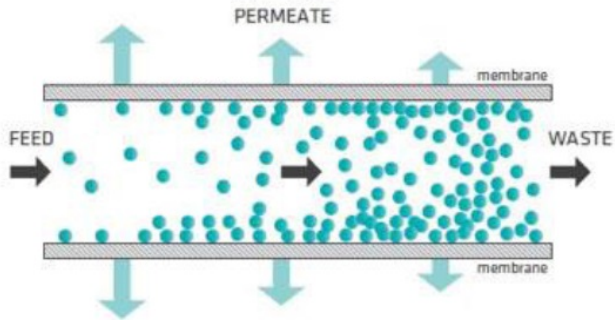
Produced water filtration with SiC membranes – state of the art technology

MICRO FILTRATION

Main benefits

- Pore size 0,4µm – outstanding removal of solids to protect the porosity of the reservoir
- Removal of smallest oil droplets to the highest possible degree
- Partial Removal of bacteria (complete removal with Ultrafiltration)
- Membranes are chemically inert – resistant to cleaning chemicals at ph 0-14 – efficient cleaning of membranes even when facing sever scaling
- High capacity flux rates - small footprint in comparison to other membrane materials
- Low fouling tendency – less cleaning frequency
- Unmatchable long life time





Produced water filtration with SiC membranes – state of the art technology

Complete system:

- Combination of single 25mm diameter x 1,2m membranes in one module housing
- Complete monitoring system
- Feed pumps, Crossflow pumps, backflush pumps, dosing pumps
- Piping, valves
- Control system
- CIP tank for acidic cleaning in place

LIQ TECH

- Leading manufacturer for Microfiltration or Ultrafiltration membranes
- Dedicated to SiC membrane technology
- Based in Denmark and listed on the NY stock exchange

Produced water filtration with SiC membranes – state of the art technology

PILOT TESTING

- Operating a pilot system on site prior to final engineering of the complete system is compulsary
- Piloting will take place with the assistance of LiqTech and SONNEK engineers

SONNEK water treatment plant

Comparison Nut shell filter – Ceramic membrane filtration

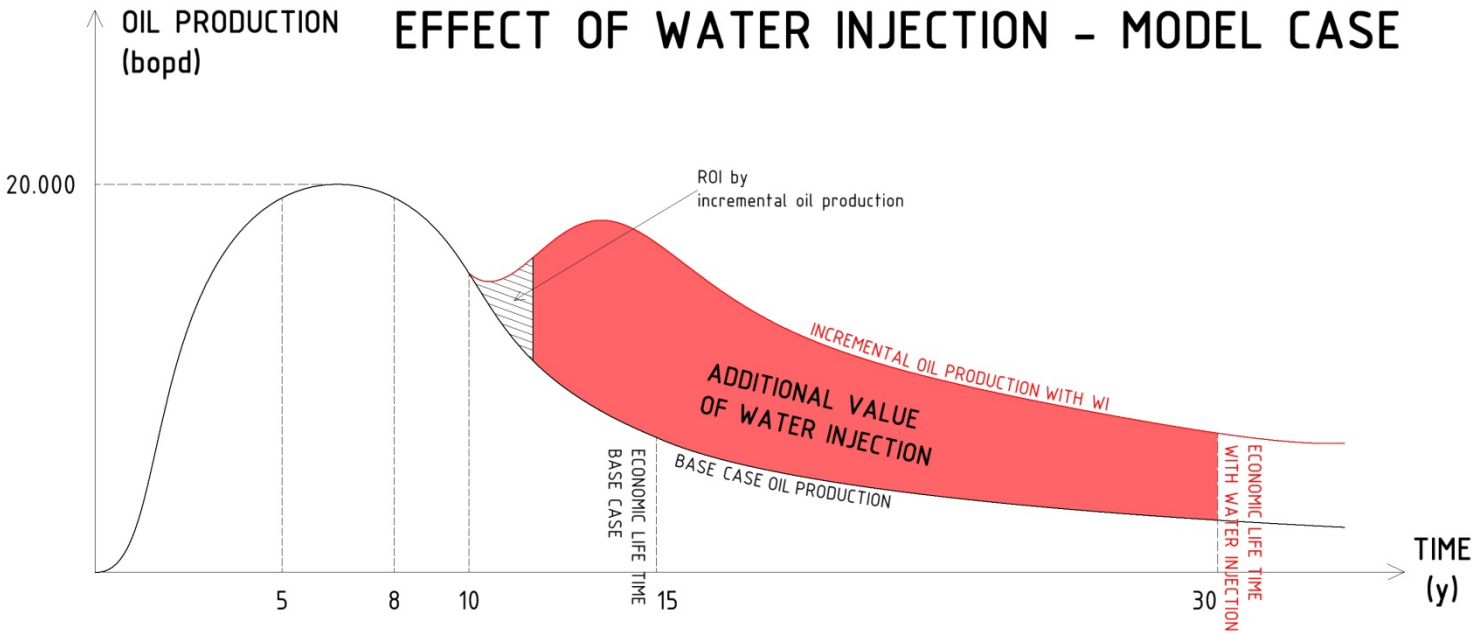
	NUT SHELL FILTRATION	SiC MEMBRANE FILTRATION
ADVANTAGES	Low operating costs	Highest filtration performance in terms of solid and oil removal
	High flux rates	Very high flux rates on small footprint
	Short backwash cycles	Cleaning of membranes with strong chemicals possible leads to very long life time
	lower investment costs	Partial removal of bacteria
DISADVANTAGES	Limitations in solid removal, especially without flocculation stage	Chemicals for cleaning required
	Oil removal rate to 5ppm might be at the limit	Higher Investment costs
	Backwash water to be equalised by other sources	Piloting required to verify scaling potential
	Amount of waste water can be expected to be higher	

Conclusion:

In case a complete reduction of suspended solids will result in benefits for the oil production (reservoir depending) a SiC micro- or ultrafiltration will be feasible

Turn Key solutions for oilfields

Output of proper water injection - conclusions:



- ✓ Increased oil production with short payback period = lower production costs per bbl
- ✓ Preserving the original field development CAPEX by doubling the economical field life time (in average)
- ✓ Doubling the oil recovery factor from 15 to 20% to 30 to 40% (in average)
- ✓ Achieving higher oil production rates instead of additional costs for produced water disposal
- ✓ Maintaining or rebuilding the required reservoir pressure
- ✓ Creating the technical base for future EOR technologies with even higher recovery rates

SONNEK Solutions